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COMMUNICATIONS

THE COMPARATIVE FREQUENCY OF DEFECTS OF VISUAL ACUITY AMONG ACCEPTED AVIATION CANDIDATES, PUPILS, AND EXPERIENCED PILOTS

BY

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THE considerable number of cases of defective visual acuity, many of high degree, met with among the experienced pilots who have presented themselves for Civilian Flying Licence (B) has suggested that a comparison of their frequency with that existing among (1) candidates accepted for training as pilots; (2) pupils who have failed during actual flying instruction ; (3) pilots recently qualified ; and (4) pilots who have gained distinctions, might afford some information as to the bearing of visual acuity upon flying capacity.

With this object in view the total number, 4,319, whose records have been examined, has been divided into five groups according to the stages reached by the individuals in their flying careers, and the frequency of occurrence and degree of defects in the various

groups ascertained for comparison. No individual with worse vision than 6/12, 6/18, has been included.

The groups, which might in some cases with advantage have been larger, are described below:

GROUP I. 3,000 candidates examined and accepted for training as pilots. The records of this group have been analysed with a view to determining the frequency with which defects of visual acuity within the limit laid down in A.C.1, 1061, 1917 (6/12, 6/18), occurred among the average accepted candidates.

GROUP II. 123 pupils training as pilots who failed to qualify—failure occurring during actual instruction in flying.

GROUP III. 633 pupils who were successful in gaining their wings.

GROUP IV. 200 pilots who have been awarded the Distinguished Flying Cross, and in some cases the Bar.

The average number of hours flown by this group is not known, but it is probably considerable though less than that of Group V.

GROUP V. 363 pilots who have been medically examined by the Board when applying for a Civilian Flying Licence (B).

This group consists almost entirely of experienced pilots with an average of 800 hours flying per man. It includes no fewer than 110 pilots, each with 1,000 or more hours to his credit, many of whom were flying before the outbreak of war.

Not included in this group were 20 pilots examined for Licence (average hours flying 1000) who were found to possess worse defects than 6/12 6/18, and are referred to later.

NOTE.—Groups II. and III. were taken from a series of candidates accepted for training as pilots, whose subsequent histories have been traced. They include all the failures during flying instruction, and all the successful pupils from the series.

The percentage of individuals in the various groups who present defects of vision up to and including 6/12, 6/18, and also the percentages of the various degrees of defects based on the totals examined, are shown in Table I.

In examining the results, Group IV. and V. should be compared with Group I. as representative of the average accepted candidates, while Groups II. and III., forming as they do the successes and failures during flying instruction of a series of pupils, should be compared with one another.

From an examination of the figures in Table I. it is seen that the percentage of visual defectives is highest among the accepted candidates, and that there is a diminution of 4 per cent. in both the pilots with distinctions and those applying for Civilian Licence.

The percentages among the successful and unsuccessful pupils are distinctly lower than that of Group I, but are practically identical with one another and with that of the series from which the two groups were taken (18·9).

In considering the percentage under the various grades of defect

TABLE I.

	Number and % of cases of defective vision 6/12, 6/18 or less.		6/6 6/9		6/6 6/12		6/6 6/18		6/9 6/9		6/9 6/12		6/9 6/18		6/12 6/12		6/12 6/18	
	No.	%	No.	%	No.	%	No.	%	No.	%	No	%	No.	%	No.	%	No.	%
Group I. 3,000 Accepted Candidates	736	24·5	283	9·4	99	3·3	21	·7	175	5·8	71	2·4	19	·6	52	1·7	16	·5
Group II. 123 Pilot Pupils Failing during Flying Instruction	23	18·7	6	4·9	4	3·3	2	1·6	5	4·1	3	2·4	1	·8	2	1·6	0	0·0
Group III. 633 Successful Pilot Pupils	118	18·6	35	5·5	20	3·2	5	·8	22	3·4	16	2·5	4	·6	13	2·1	3	·5
Group IV. 200 Pilots with Distinctions—D.F.C. ...	41	20·5	25	12.5	3	1·5	0	0·0	9	4·5	3	1·5	1	·5	0	0·0	0	0·0
Group V. 363 Pilots applying for Civilian Licence. Average hours flying, 800.	73	20·1	30	8·3	8	2·2	6	1·6	21	5·8	4	1·1	1	•3	2	·5	1	·3

within the standard allowed, it is thought advisable, in view of the small numbers with the higher defects, to group the defectives in two classes for purposes of comparison.

1. Those with small defects, *i.e.* ... 6/6 6/6 6/6 6/9 6/9 6/12 6/18 6/9
2. Those with large defects, *i.e.* ... 6/9 6/9 6/12 6/12 6/12 6/18 6/12 6/18

It is to be noted that those with normal vision in the better eye are placed among the class of small defects, as vision with both eyes together would be equivalent to 6/6.

The number of defectives in the various groups classed in this way are shown as percentages of the totals examined in Table II.

TABLE II.

	Per cent. Small Defects.	Per cent. Large Defects.	Per cent. with either Defects.
Group I. 3,000 Accepted Candidates	19·2	5·2	24·5
Group II. 123 Pilot Pupils Failing	13·9	4·8	18·7
Group III. 633 Pilot Pupils Qualifying	12·9	5·7	18·6
Series from which Groups II. and III. were taken	13·9	5·0	18·9
Group IV. 200 Pilots with Distinctions	18·5	2·0	20·5
Group V. 363 Civilian Pilots	17·9	2·2	20·1

A comparison of the figures in the Pilot Pupil Groups I. and III. reveals little difference in the percentages of either small or large defects, and it appears that in the series from which these groups were taken defects of visual acuity of whatever degree within the limit of 6/12, 6/18 did not affect adversely the pupil's chances of success in gaining his wings.

Comparing Group I. with Groups IV. and V. there is a diminution in the number of small defects in the two latter groups amounting to no more than 0·7 and 1·3 per cent., respectively, while the percentages of those with the higher defects among distinguished

pilots and applicants for Civilian Licence are less than half that found in the group of accepted candidates and are certainly suggestive of some falling out of men with these defects.

If it be proved that the larger defects have diminished the pilot's prospects of flying on active service with distinction or of flying successfully over long periods, it will still remain to be shown whether the defect has affected his "flying" as distinct from his "fighting" capacity. Bad landings, defeat in aerial combat, or nervous breakdown, with which the defective vision may be correlated, are all possible causes of this elimination of the larger defects.

There are still to be considered the 20 pilots (average hours flying 1,000) presenting defects higher than 6/12, 6/18 who have not been included in Group V.

The degrees of defect in these pilots are shown in Table III.

TABLE III.

6/6 6/24	6/6 6/36	6/6 6/60	6/9 6/24	6/9 6/36	6/12 6/24	6/18 6/18	6/18 6/24	6/18 6/36	6/60 6/60
3	1	5	1	2	1	3	2	1	1

It is impossible to say how the frequency of these defects (5.3 per cent. of 383) among pilots examined for Civilian Flying Licence would compare with that found in a series of accepted candidates which included individuals suffering from such defects, but otherwise fit for aviation, as no records are available for comparison. The percentage is certainly higher than that found among the candidates who presented themselves for examination at the Medical Board, but this comparison is without value owing to the preliminary weeding out of many such defectives, which had already taken place.

It does, however, appear possible that so far as actual flying is concerned these defects of worse degree than 6/12, 6/18 may prove to be a less serious handicap than those of moderate grade, inasmuch as those suffering from the former generally recognize their disability and wear correcting glasses, whereas the possessors of moderate defects, confident in their own unaided vision, frequently discard the corrections which are ordered.

Summary

(1) Among the successes and failures of the pilot pupil groups there is little or no variation in the frequency of defects of visual acuity within the limit previously laid down.

(2) Comparing the groups of pilots of long experience and distinction with the accepted candidates, a diminution in the frequency of visual defects amounting to 4 per cent. of the total numbers examined is apparent in the former.

(3) Three quarters of this diminution has occurred in the larger, and one quarter among the smaller defects.

(4) Of 383 experienced pilots, 93, who in the aggregate had flown for 75,000 hours, failed to reach the standard of normal vision in each eye. Of these, 65 had small and 8 large defects within the standard fixed, while 20 had defects ranging from 6/12, 6/18 as high as 6/60 in each eye.

THE RADICAL CURE OF GONORRHOEAL IRITIS.*

BY

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BACTERIOLOGIST TO THE ROYAL LONDON OPHTHALMIC HOSPITAL AND ALL SAINTS' HOSPITAL FOR GENITO-URINARY DISEASES.

GONORRHOEAL iritis being a late sequel of gonorrhoea, is not as a rule seen first hand by a specialist in venereal diseases, with the result that it is more often than not treated as a local affection. In this way it has come to be talked of as "recurrent iritis," whereas few if any cases of gonorrhoeal iritis ought to occur in the first place, and certainly ought not to recur if properly treated.

The object of this paper is to try to show that by proper treatment of the genito-urinary tract and the cure of the disease existing there, a permanent cure of the gonorrhoeal iritis will follow; also to bring to the notice of ophthalmic surgeons their responsibility in seeing that their cases of gonorrhoeal iritis are adequately treated in the way I shall indicate. Gonorrhoeal iritis is, I think, a toxic condition and is not due to the presence of the gonococcus in the eye, for this organism has only been isolated from the eye in one case (Sidler-Huguenin), and then only from the blood stained exudate from the anterior chamber of a patient suffering from acute gonorrhoeal septicaemia. I have examined the gelatinous exudate from cases of gonorrhoeal iritis under the care of Mr. Lang, but have not been able to cultivate the gonococcus or find the organism in direct smears. These experiments were carried out under the most favourable conditions as the exudate was in all cases planted out on to suitable media within a few seconds of being drawn off.

Then, again, the rapid cures I have sometimes had after vaccine

*Read in the Section of Ophthalmology of the Royal Society of Medicine on Feb. 4, 1920.

treatment more closely resemble recovery from a toxic condition than a microbic one.

That the iritis is gonorrhoeal is suggested by the following observations:

1. There is generally a definite history of gonorrhoea some years previously. I may here mention that I have never seen a case of iritis during the acute stage of an urethritis, which observation is confirmed by Mr. Canny Ryall, of All Saints' Hospital, and also by Mr. C. H. Mills, who has been a specialist at the Military Hospital, Rochester Row, for the last five years. The observations of these two surgeons must run into many thousands of cases.
2. The specific reaction to gonorrhoeal vaccines.
3. Its association with gonorrhoeal rheumatism, though this is by no means invariably the case.
4. The recurrence of iritis or exacerbation of symptoms after prostatic and vesicular massage, probably due to the liberation of toxins and bacteria—dead or alive—into the blood stream.
5. By negative evidence; that is to say, by eliminating as far as possible all other sources of infection such as pyorrhoea, septic tonsils and ears, cystitis, alimentary infections, etc.

I have not mentioned the complement fixation test in the above list, as I did not do it in any of the cases I am about to record, and also because in my hands it has not yet proved reliable and I do not yet know of a method which gives consistently true results.

Treatment.—Treatment must be considered under two headings, preventive and radical.

The preventive treatment of gonorrhoeal iritis really rests with those who see the gonorrhoea in its early stages, as no case of gonorrhoea can be said to be cured till the prostate and vesicles have been carefully examined, and proved by repeated examination of their contents, expressed by massage, to be free from infection. Examination with the urethroscope should also be carried out. I believe that if the above examinations were done by a specialist in genito-urinary work and a bacteriologist familiar with the examination of urines after massage, there would be no such eye condition as "gonorrhoeal" iritis.

I think that it is now generally recognized that all cases of gonorrhoea should be treated with vaccines, for although they do not materially shorten the acute stage of the disease, there is considerable evidence to show that complications and sequelae are to a large extent prevented by their use. The radical treatment of gonorrhœal iritis I would suggest to be as follows:

1. The immediate treatment by the ophthalmic surgeon.
2. The immediate treatment by vaccines.
3. Continued treatment by vaccines and prostatic and vesicular massage with treatment of the urethra if necessary.

1. Of the immediate and continued treatment by the ophthalmic surgeon I of course can have nothing to say, but the responsibility generally rests with him as to whether the subsequent treatment is advised or not.

2. I am convinced that the immediate treatment by gonococcal vaccines is essential if the best is to be done for the patient. The acute attack is often cut short and the relief to the patient as regards pain is definite.

An autogenous vaccine should be used if possible, but while this is being prepared suitable doses of a reliable mixed vaccine may be given.

Vaccine therapy has rather gone out of fashion and repute the last few years, and this I think, is due to the haphazard use of commercial vaccines by persons unskilled in vaccine therapy. Vaccines freshly prepared from many strains are necessary for stock use, and this is seldom obtained in those bought in a chemist's shop. However, I have found the French preparation called "Dmégon" and Mulford's vaccine to be really good and reliable.

The dose of vaccine varies with each patient and I have used initial doses of from 5 to 500 millions with success. I would here remind you that vaccine therapy is an aid to general medical and surgical treatment and is in no way intended as a substitute.

3. I now come to an important part of the treatment and that is the examination of the genito-urinary tract. Practically every case of gonorrhoeal iritis I have examined or have had examined, has shown some disease of the prostate or vesicles, and massage of these organs has shown the presence of pus cells and often gonococci. The cure of the iritis depends on the cure of the accompanying prostatitis or vesiculitis and this is generally brought about by massage.

Massage of the prostate and vesicles is a difficult and arduous operation and unless done by an expert is useless, as much judgment must be used as to how much or how little massage any one prostate will stand. Only those thoroughly familiar with the normal and diseased organs can carry out the treatment successfully.

The method usually adopted is as follows:

The patient is told to come with a full bladder, and before massage a little urine is passed into a specimen glass in order to test for threads, pus, or micro-organisms. He then gets up on to a couch or table in the knee-elbow position and the well lubricated forefinger is passed into the rectum. The prostate is then massaged with a sweeping motion round the edges of the lobes, first on one side and then on the other, firm pressure being applied all the time and working towards the centre; this is continued for two or three minutes. The finger is then passed over the prostate and the vesicles are massaged and emptied of their contents, pressure is

applied to the abdomen with the left hand at the same time in order to push the bladder back and thus enable the vesicles to be more easily reached. This is an important point.

The patient then passes his water into a glass and the centrifugalized deposit is examined for pus, gonococci or other organisms.

Gonococci are not found in all cases of iritis, but this is probably due to the difficulty of detecting the organism which is often swollen and stained badly, or is lost in a mass of spermatozoa, pus cells, epithelium, and other organisms, but the fact remains that even when the gonococcus is not found the iritis is cured when the urine examined after massage repeatedly gives a normal desposit.

I do not think that iritis is often due to the other bacteria found after massage, such as staphylococci, B.coli, diphtheroids, etc., though Mr. Canny Ryall has told me of a case of iritis in which a pure culture of the bacillus coli was isolated from the urine after massage and which was cured without recurrence after suitable treatment. I have not yet seen a case of gonorrhoeal iritis in a female. The following is a list of some of the cases I have treated or had treated by Mr. Canny Ryall or by Mr. C. H. Mills and my thanks are due to them for the great trouble and interest they have taken with the cases, also to Mr. Lang, Mr. Worth, Mr. Hudson, Mr. Greeves, and Mr. Whiting for permission to publish their cases.

I have followed up these cases as far as possible, and with one exception there has not been a recurrence for at least the last five years.

The recurrence was in a case of Mr. Worth's, and he came to see me last month with an acute iritis and begged for vaccine treatment and a letter to All Saints' Hospital. He had been to this hospital before, but for certain reasons had been unable to continue treatment, although he was told he was not cured. He had been four and a half years without a recurrence. Mr. Ryall saw the case and demonstrated the enlarged prostate and matted vesicles to be felt in the rectum. Examination of the urine after massage showed the presence of many pus cells and a considerable number of gonococci. He is now undergoing a thorough course of massage and vaccine treatment.

CASE 1. A., married. History of gonorrhoea 18 years ago; slight rheumatism at times, recurrent iritis for last six years; left iridectomy, massage, and vaccines, cured.

CASE 2. B. History of gonorrhoea six years ago, sixth attack; massage and vaccines; cured.

CASE 3. C. Many attacks of recurrences of gonorrhoea, often with rheumatism; cannot remember the date of first attack. His wife has chronic "tubes"; no children. A difficult case, which developed another attack during treatment, but eventually cleared up completely and there has been no recurrence for the last five years.

CASE 4. D. History of gonorrhoea five years ago; no rheumatism; two attacks of iritis; cured.

CASE 5. E. History of gonorrhoea six or seven years ago; cured.

CASE 6. F. History ten years; did not improve much with vaccine treatment alone, but got quite well with massage and vaccines combined.

CASE 7. Mentioned above.

CASE 8. O. R. History of gonorrhoea 17 years ago; first attack of iritis; massage and vaccines; cured.

CASE 9. M. J. History two years; third attack of iritis in five months; cured.

CASE 10. I. M. S. History of many attacks of gonorrhoea with acute epididymitis and prostatitis; one eye practically blind as the result of many attacks of iritis, cured.

Gonococci were found in the material obtained after massage in all the above cases.

THE ACTION OF HYPOPHYSIN (PITUITRIN) UPON THE PUPIL OF THE RABBIT*

BY

W. B. INGLIS POLLOCK

GLASGOW.

Introduction

THE problem of the determination of the precise seat of action of drugs has proved one of the most difficult in the whole range of pharmacology. Especially is this the case as regards their action on visceral muscular structures. While, in the skeletal muscles, a definite fibre extends from a cell in the central nervous system to one or more muscle fibres where it ends in definite end-plates, in visceral muscles the fibre is interrupted at least once in its course, and this interruption may occur almost anywhere between the spinal cord and the muscles supplied. It is generally assumed that there is but one synapse, one cell station in each fibre, but the evidence for this is far from conclusive.

Probably the most satisfactory evidence is that afforded by the action of nicotin on the heart of the frog. The vagus endings are paralysed, but the augmentor nerves still act. Hence the conclusion is arrived at that the former have their cell station in the heart, and the latter in the stellate ganglion. But while such an experiment indicates that the greater proportion of synapses of the former are

* From the Department of Physiology, University of Glasgow.

in the heart, and the greater proportion of the latter are extra-cardiac, it does not prove that there are no synapses outside the heart in the former, or in the heart in the latter.

The fact that in certain animals, *e.g.*, some ducks, Noël Paton[1] found that stimulation of the vagus leads to augmented action, seems to indicate that augmentor fibres stream out by the vagus as well as by the sympathetic; and Miss Abel's studies[2] of the emigration of the neurons of the automatic system certainly give no support to the existence of one definite synapse in the course of each fibre and suggest a much less sharply demarcated distribution, with the possibility of several interruptions.

Again, if there is but one interruption in each autonomic fibre, the excision of the seat of the interruption should cause a complete disappearance of the nerve fibres in the part supplied. On this subject few observations have been made. Fletcher[3] found, after excision of the first pelvic ganglion and section of the pudic nerve of the same side that the muscular plexus in the retractor penis of the hedgehog did not stain with methylene blue. He, therefore, assumed that "the peripheral nerve endings in the muscle did disappear when a section of both the inhibitor and motor sets of fibres was affected," and that "it points to the non-existence of any local trophic centres within the peripheral end-apparatus itself." Fletcher himself admits that his results were not conclusive.

Anderson[4] in his large series of beautiful and painstaking experiments on the iris apparently did not make observations on the disappearance or persistence of a peripheral plexus after removal of the superior cervical and ciliary ganglia which he concludes leads to complete denervation.

The existence of a rich peripheral plexus of nerve fibres and nerve cells in the iris has been demonstrated by Münch[5] and Schock.[6] Does this consist of neurons beyond the ciliary ganglia which have been displaced from the two cardinal ganglia?

Jegerow[7] has shown that certainly all the synapses on the third nerve are not in the ciliary ganglion, but that more peripheral ganglia exist. May the plexus in the iris be simply the most peripheral of the outlying stations, or is it a plexus beyond the post-ganglionic fibres?

Whichever it may be, there seems good reason to believe that it can survive the complete removal of the cardinal cell stations.

The author[8], in a previous paper, has shown that the motor plexus with nerve cells lies between the individual cells of the sphincter and dilator pupillae of the rabbit, and that it contains fibres of extreme tenuity. "The plexus persists after separation of the iris from the central nervous system by removal of the ciliary ganglion, and of the superior cervical sympathetic ganglion. It

may, therefore, be regarded as of the same nature as the plexuses of Auerbach and Meissner in the intestine."

Objections have been raised to these results on the ground that the author had not removed the accessory ganglia described by Jegerow. In the operation for removal of the ciliary ganglion described by him in that paper[9] the ciliary ganglion and the short ciliary nerves were all removed and a clean sweep made around the optic nerve at its entrance to the eyeball. He found that this and also complete removal of the superior cervical ganglion up to its uppermost portion was necessary in order to exclude all extrinsic nerve fibres from the iris. By this means, extrinsic sensory fibres were also removed.

Another objection has been raised to the author's work by suggesting that the cells figured were plasma cells, and the fibres elastic fibres. These cells and fibres were found in silver stained specimens as well as in those stained by the intra-vitam method of methylene blue staining, described by Hosch,[10] which was based on the method of Dogiel[11]. These nerve cells have been described by earlier workers with gold chloride, and also by Münch,[5] and Schock,[6] who employed the phosphomolybdic acid fixation method. The author did not find it difficult to distinguish the nerve cells from the stroma and plasma cells, as he had worked for a number of years on the pathology of the eye. The nerve fibres were of extraordinary fineness in the Cajal silver stained specimens, and required an oil immersion lens for their discovery.

Certain fibres could be followed for long distances in the sphincter plexus, and they could easily be distinguished from elastic fibres. With the methylene blue stain, fine fibres were also obtained. The plexuses in the sphincter muscle and in the dilator muscle appeared to be quite distinct from a plexus with few nerve cells and long delicate nerve fibres stretched widely through the iris. These plexuses were found both in the normal iris and in the iris after complete removal of the ciliary ganglion and its accessory ganglia, and the superior cervical sympathetic ganglion.

This being so, it seems so far impossible to speak of a "denervated" iris, or to conclude from the persistence of the action of drugs after removal of the cardinal ganglia that their action is upon the muscle. To argue an action on some neuro-muscular junction seems unwarrantable. The evidence we possess of the behaviour of denervated skeletal muscle indicates that, in time, this neuro-myal junction degenerates. We have no right to assume that it will persist in visceral muscle.

But the main point is that so far we cannot talk of a denervated iris, and therefore, that we cannot conclude that a drug producing its effect after so-called denervation is acting upon non-nervous structures.

Post-ganglionic fibres degenerate in two days (Tuckett[12]), and yet adrenalin stimulates the dilator pupillae for many months after so-called "denervation." This means that it acts upon the endings of peripherally placed ganglia, that some hypothetical neuro-muscular ending persists, or that it acts directly upon the contractile part of the muscle fibre. But which it is we at present do not know, nor have we any means of determining.

What applies to adrenalin applies also to other drugs, *e.g.*, physostigmin and pilocarpin. The former of these ceases to act when the nerve degenerates after section while the latter continues to act, and the conclusion is that the latter acts on the neuro-myal substances, or on the muscle. The former conclusion is unwarranted, and the latter is unjustifiable until it has been definitely shown that all the nerve plexus of the iris has disappeared.

The general validity of Elliott's law[13] that adrenalin acts upon the nerve endings of the true sympathetic (thoracico-lumbar visceral) nerves, and that it acts with greater persistence after degeneration of the motor post-ganglionic fibres, and with more prolonged inhibition after degeneration of the inhibitor post-ganglionic fibres, may now be held as accepted.

Brodie and Dixon[14] held that adrenalin acts on a neuro-muscular junction. Elliott[15] proposed the "myo-neural junction which is irritable by adrenalin" and "is on the muscular side in so far as its trophic centre lies in the muscular nucleoplasm." Anderson[16] proposed the word "myoneure" for the myo-neural junction.

The fact that there is no evidence that the neuro-myal substance of visceral muscle should survive nerve degeneration any more than the same substance in skeletal muscle, the fact that it has never been shown that the peripheral plexus disappears after so-called "denervation" and the evidence afforded by myself of its persistence all indicate that adrenalin probably acts upon some persistent nerve structure, and that other drugs may act upon this, or upon the muscle directly; but in which way they act the simple observation of their influence on the so-called "denervated" iris does not tell us.

The possibility of coming to some more definite conclusion by the study of the relative action of different substances seemed worth investigating. Light might be thrown upon this point; first, by the study of the relative activity of different drugs on the norma and on the "denervated" iris; secondly, by the study of the influence of thyroid extracts which are known (Asher and v. Rodt[17] and Oswald[18]) to activate the endings of both true and para-sympathetic upon the influence of adrenalin and pituitrin on the pupil.

At the same time, it seemed desirable to attempt to get more definite information upon the somewhat contradictory statements as

regards the action of pituitrin (hypophysin) on the pupil, and to study further the action of β-iminazolyl-ethylamine and of guanidin. The peculiar nicotin-like action of guanidin discovered (Noël Paton and Findlay[19], Meighhan[20]) in this laboratory, made it interesting to investigate its action on the pupil.

The work thus divides itself into:

1. A study of the action of hypophysin* on the normal and deganglionated ("denervated") iris, and a comparison of its effects with those of adrenalin. This is dealt with in the present paper.

2. A study of the relation of the action of adrenalin and pituitrin, and of physostigmin and pilocarpin on the normal and deganglionated iris.

3. An investigation of the influence of thyroid extracts upon the action of adrenalin and pituitrin on the iris.

4. A study of the influence of β-iminazolyl-ethylamine and guanidin upon the pupil.

5. A general consideration of the evidence afforded by these experiments, and the light thrown by them on the validity of the conclusions generally held as to the seat of action of these drugs.

These last four subjects will be considered in subsequent papers.

Present Investigation

(i) *Methods.* For the purposes of this investigation Messrs. Parke, Davis & Co's preparation of pituitrin has been used, and has been held as equivalent to the extract of the hypophysis.

Pituitrin is preserved by the addition of a small quantity of chloretone. Pankow[21] found that this drug had no action on blood pressure, or involuntary muscle. Wiggers[22] got similar results.

The capsules supplied by the firm for subcutaneous injection were opened and the contents applied to the conjunctiva by instillation. The solutions were dropped into the eye from a fine pipette, or from a 1 c.c. hypodermic syringe.

In these experiments two drops were administered to each eye on each occasion, except in certain experiments when the fact is mentioned. The first and third drops were given on one side, with the second and fourth to the other eye, the right being always the operation side, while the left was kept as a control, no operations being performed on that side. The drops were twice repeated to each eye at intervals of fifteen or twenty minutes. Six drops were, therefore, applied as a rule to each eye in the course of an hour.

In other experiments pituitrin was given by intravenous injection.

The illumination was maintained at that known as slightly darkened. This gave enough light for accurate measurement of the pupils, and, at the same time, allowed the sphincter to relax under

*By hypophysin is meant the extract of the posterior lobe of the pituitary, the hypophysis cerebri.

these conditions. Care was taken to maintain equal illumination on each side of the head during the examination, for which purpose the rabbit was placed in the special holder devised by Chasseaud[23], with its back to the window where it sits placidly for a considerable interval. It is necessary to give the animal a rest of a minute or two each time it is placed in the stand before taking the measurements, as the handling usually dilates the pupils.

The pupils were measured by direct examination by means of Fay's patent outside calipers (Messrs. Starrett & Co.). The measurements were taken to quarter millimetres on a millimetre scale. Each pupil was measured both in the vertical and horizontal diameters, before and after the application of the solutions, although in one or two of the earliest experiments they were measured more frequently.

It is important to stand exactly opposite the rabbit's eye, and to keep the points of the calipers in the direct line of vision and within 5 mm. of the cornea. It is usually best to employ only one eye in watching the points of the calipers and the margins of the pupil.

(ii) In the first experiments the right superior cervical sympathetic ganglion was removed in each case, except in the instances in which the sympathetic nerve of the same side was cut in the neck below the ganglion and the ends separated. In removing the ganglion it is necessary to excise the entire ganglion, as pointed out by Langley and Anderson[24] who found that the cells for the dilator muscle of the iris are situated in the upper half of the ganglion.

(iii) In another series of experiments the right ciliary ganglion and accessory ganglia were removed by the operation described in the introduction. After excision of the ciliary ganglion the short ciliary nerves were removed and the optic nerve sheath thoroughly cleared of nerve structures by gently scraping it above, below and externally. Complete removal is necessary of the ciliary ganglion and accessory ganglia so beautifully described and figured by Jegerow.[25] In my previous paper the test for this consisted in the presence of medullated fibres in the iris. If any such were still present complete excision had not been performed. In the present investigation there has been no time for pathological examination of the iris after the animal's death.

Some of the sensory fibres passing through the short ciliary nerves are also removed by this operation and the cornea seems to become easily liable to injury. It is, therefore, better to suture the lids together for a week, when the stitches may be safely removed.

In two instances the right pre-ganglionic fibres of the sphincter pupillae were cut immediately above the ciliary ganglion without disturbing, in so far as was possible, the vascular supply of the ganglion.

(iv) In the last experiments the right superior cervical ganglion and the ciliary ganglion and accessory ganglia were excised so as to give a completely deganglionated iris on the right side.

Anderson[26] employed the term "decentralised" for the cases in which the pre-ganglionic fibres were cut, and the term "denervated" for the cases in which the ganglion was excised, or the post-ganglionic fibres cut.

As already indicated, I do not agree with this latter term. I have, therefore, employed the terms "deganglionated," used by Dale and Laidlaw[27] for the cases in which the ganglion was excised, and Anderson's "decentralised" for the cases in which the pre-ganglionic fibres were cut.

Fourteen days were allowed for degeneration of nerves before investigating the action of the different drugs. No observations were made after the 150th day, so that the possibility of regeneration may be excluded (Tuckett[28], Langley[29].)

All operations were performed on the right side in every case, so that the left was retained as the normal or control side throughout the series.

I.—The Normal Iris

Historical Summary.—While the general action of extracts of the pars intermedia of the pituitary body, or of the hypophysis cerebri has been fairly definitely ascertained as the result of a great amount of work by many observers, their effect upon the pupil of the eye has given apparently contradictory results in the hands of competent workers.

After Ehrmann[30] had suggested in 1905 the mydriasis produced in the enucleated eye of the frog as a method of detecting the presence of adrenalin, a number of other substances and extracts from different organs in the body, including the hypophysis, were discovered to have the same effect, and the method was abandoned.

Gramer[31] in 1908 was the first to describe this action with extracts of the posterior lobe of the pituitary body of the ox. Strong extracts produced a dilatation within an hour or two, which was as great as that obtained from adrenalin, and, although slower in development, it lasted longer. Dilute extracts took twelve or more hours to produce a moderate dilatation. During the same time, the pupil of the control eyeball, immersed in Ringer's solution, became completely contracted. Extracts from the anterior lobe produced a complete contraction of the pupil in sixteen hours.

These results were confirmed by Borchardt[32] in 1908, by Pal,[33] and by Bayer[34] in 1909.

In the same year Dale,[35] in the course of an important paper upon the action of extracts of the pituitary body, stated that there was no action upon the mammalian pupil.

In 1910, Frankl-Hochwart and Fröhlich,[36] reported that the intravenous injection of 0.4 c.c. pituitrin produced a contraction of the pupil in rabbits.

Kepinow[37] in 1912 confirmed this result for cats and rabbits when a sufficient concentration of the extract of the hypophysis was employed for the intravenous injection. He further stated that he found that the extract of the entire gland which he was using produced a miosis in the enucleated eyeball of the frog.

But Cramer[31] had already shown that a miosis occurred in the frog's pupil when it was placed in Ringer's solution, plus an extract of the anterior lobe, or even in Ringer's solution alone. The miosis observed by Kepinow[37] must, therefore, be attributed to the solution of the extract of the posterior lobe being weakened by the action of the extract of the anterior lobe, and of the sodium chloride solution in which the eyeballs were first immersed. The mydriatic action of the posterior lobe was overcome by these other factors.

These results, however, were subsidiary to the main purpose of his investigations, which was to decide whether adrenalin and the extract of the hypophysis were synergists, but this subject will be taken up in a later paper. Gottlieb[38] also stated in the same year that he found a miosis occurring in the frog's pupillary reaction.

Meltzer[39] in 1912 found that pituitrin produced in the enucleated frog's eye a dilatation of the pupil, in most instances, which was never as striking as that obtained with adrenalin. In a smaller number, no dilatation took place, but in no case was there a contraction of the pupil. In six rabbits he removed one superior cervical ganglion, and injected 1, 2, or 3 c.c. pituitrin intravenously, and did not find a dilatation "neither soon nor late on the operated side." Both pupils, and especially that on the operated side, showed a constriction of short duration immediately after the injection.

Fröhlich and Pick[40], in 1913, while investigating the action of ergotoxin upon the rise in blood pressure produced by the extracts of hypophysis, and adrenalin, which had been discovered by Dale[41], found an interesting result in the pupil of the cat. They confirmed that ergotoxin inhibited the action of adrenalin and that the extract of the hypophysis (Burroughs, Wellcome & Co.) was not inhibited. If the extract was employed in a strength just enough to cause a mere rise of pressure after ergotoxin, and was followed by a small dose of adrenalin, striking rise of blood pressure was obtained, but the pupils remained contracted, which they attributed to ergotoxin.

Githens[42] has recently, 1917, stated that ergotoxin produces a dilatation of the pupil in rabbits.

Githens and Meltzer,[43] in 1916, reinvestigated the pituitrin question. They found, in the normal animal, that the intravenous injection of pituitrin produced a considerable constriction of the

pupil, while adrenalin produced a moderate dilatation of short duration. When both drugs were injected simultaneously, the dilatation was much less than with adrenalin alone. They held that pituitrin produces constriction of the pupil, and "*counteracts* to a degree the dilating effect of adrenalin."

Although adrenalin produces a dilatation of the pupil after intravenous injection in nearly all animals, Langley,[44] Brodie and Dixon[45] and Elliott[46] have shown that a constriction of the pupil occurs in the dog.

Elliott[46] investigated the point and found that adrenalin produced a dilatation of the pupil when injected into the anterior chamber, or into the common carotid, but not on instillation into the conjunctival sac. He found, on the other hand, that when small doses of adrenalin were injected intravenously, the pupil contracted, while the globe of the eye sank backward and was twisted inward. He concluded that the local mydriatic action of adrenalin had been overpowered by the constriction due to central stimulation of the third cranial nerve by high intracranial pressure, because the constriction of the pupil, and the movement of the globe, did not occur if the mid-brain had been destroyed. When he increased the amount of adrenalin to 2.3 mgm., for which purpose the blood had to be defibrinated, he was able to obtain a moderate dilatation of the dog's pupil. With a medium dose of 1 mgm. the local mydriatic action of adrenalin is thus seen to be overcome by the contraction of the sphincter pupillae in response to the increased blood pressure stimulating the cranial third nerve.

In involuntary muscle in the intestine, and in the muscle of the uterus, there is no immunity produced by a first dose, although Bayer and Peter[47] noticed a diminution of effect with frequently repeated applications to the isolated intestine; but Pankow[21] found, on the contrary, that a small dose of pituitrin might sensitize the uterus so that a second injection of the usual amount then gave a much greater effect than was normally produced.

Present Position.

The work of previous investigators is seen, therefore, to fall into two divisions. On the one hand, extracts of the posterior lobe of the pituitary body or pituitrin produces a dilatation of the pupil in the enucleated eyeball of the frog; while, on the other hand, an intravenous injection causes a constriction of the pupil in warm-blooded animals.

There is no record of previous work on the local application of pituitrin to the eyeball in warm-blooded animals by instillation.

The present experiments have been mainly devoted to this method of investigation.

Experiments

The following experiments were performed by the methods described in the introduction.

Experiment 1, Rabbit 3.—Right superior cervical sympathetic ganglion excised.

121st Day.

3.15 p.m. Right pupil 7.25 × 6.25 mm. Left pupil 8 × 7 mm. 2 drops of pituitrin applied to each eye.

3.30 p.m. Right pupil 7.25 × 6.25 mm. Left pupil 8.5 × 7.5 mm. 2 drops of pituitrin applied to each eye.

3.45 p.m. Right pupil 7.75 × 6.75 mm. Left pupil 8.75 × 8 mm. 2 drops of pituitrin into each eye.

4.15 p.m. Right pupil 8 × 7 mm. Left pupil 9 × 8 mm. The right pupil dilated 0.75 × 0.75 mm. The left pupil dilated 1 × 1 mm. during 1 hour.

Experiment 2, Rabbit 4. Right superior cervical sympathetic ganglion excised.

96th Day.

11.15 a.m. Right pupil 6 × 5.5 mm. Left pupil 7 × 6 mm. 2 drops of pituitrin in each eye.

11.30 a.m. 2 drops of pituitrin in each eye.

11.45 a.m. 2 drops of pituitrin in each eye.

12.15 p.m. Right pupil 7 × 6.25 mm. Left pupil 7.5 × 7 mm. The right pupil had dilated by 1 × 0.75 mm., and the left had dilated 0·5 × 1 mm. in the course of 1 hour.

Discussion of Results

The action of pituitrin upon the normal iris was observed in thirty-two experiments upon twelve rabbits. In thirty cases a dilatation of the pupil followed the instillation of pituitrin into the conjunctival sac.—Table I, right half.

In one experiment, the pupil contracted during the first fifteen minutes, and then dilated to its original dimensions. In only one instance did the pupil contract and remain smaller at the end of the experiment than it was at the outset.

The numbers are not very large, but the total number of actual dilatations gives a percentage of 93.75. The average dilatation observed in these thirty cases was 0.72 mm. in the vertical diameter by 0.62 mm. in the horizontal diameter.

The greatest dilatation was 1.5 mm., and the least dilatation observed was 0.25 mm. in each diameter. The pupil, therefore, did did not reach a maximal dilatation in any instance.

The rabbit's pupil is slightly oval, and, in a number of cases, the dilatation was equal in both dimensions, but the pupil frequently became either a little more oval or sometimes more circular.

TABLE I.

	Deganglionated Dilator.				Control Side		Normal Iris.	
	Dilatation.		Constriction.		Dilatation.		Constriction.	
	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.
Rabbit 1	1	0.5						
	0.5	0.5					0	0
2	1	0.5						
	1	1			1.5	1.5		
	1	1			1.25	1		
			0	0	1.25	1		
3	1.5	1.5			0.5	0.5		
			-0·75	-1			-0.25	-0.5
	0.75	0.75			1	1		
	1	0.75			0.25	0		
	1	1			1	0.75		
4	1	0.75			0.5	1		
	1	0.75			0.75	0.25		
	1	0.75			0.75	0.25		
5	0.75	1			0.25	0.5		
	0.5	0.5			0.25	0.25		
	0.75	0.75			0.25	0.25		
7	0.5	0.75			1.5	0.75		
	0.25	0.25			0.5	0.25		
	1	1			0.5	0.5		
Average ...	0.86	0.77						
	Decentralised Dilator.							
Rabbit 6	0.75	0.5			0.5	0.5		
	1	0.75			1	0.5		
	1	1			0.75	0.75		
8	0.5	0.75			1.5	0.75		
	0.5	0.5			0	0.25		
	1	0.5			0.75	0.75		
Average ...	0.79	0.66						
	Deganglionated Sphincter.							
Rabbit 9	1	1			0.5	0.5		
	0.5	0.75			0.5	0.5		
11	0.75	0.5			0.5	0.5		
	1	0,75			0.75	0.75		
Average ...	0.81	0.75						
	Decentralised Sphincter.							
Rabbit 10	0.5	0.5			0.5	0.5		
	0.75	0.5			0.75	0.75		
12	0.75	0.5			0.75	0.75		
	0.75	0.75			1	1		
Average ...	0.62	0.56			0.72	0.62		

The observations were usually made upon several rabbits at the same time, and the change of form in the pupil might be observed to be more marked in one or two cases; but, when the results are taken in the aggregate, it is found that this increase or diminution in the ellipse of the pupil occurred with each rabbit at one time or another. The pupils always remained more elongated in the vertical meridian than in the horizontal meridian, and on no occasion did they become perfectly circular.

The rabbit which gave in its second experiment a constriction of the pupil of 0.25 by 0.5 mm., had, on four other occasions, a dilatation of the pupil. The measurements taken during the second experiment showed that the pupil contracted slightly, then dilated to normal, and then contracted slightly again.

II.—The Deganglionated Dilator Pupillae

Historical Summary.—Meltzer[39] in 1912, in the experiments to which reference has already been made, found that after removal of the superior sympathetic ganglion an intravenous injection of pituitrin produced immediately, especially on the operated side, a constriction of short duration.

Githens and Meltzer[43] in 1916 again reported that the injection of pituitrin caused a constriction of the pupil in the rabbit with a deganglionated dilator; and that it lessened the dilatation produced by adrenalin when both were injected simultaneously.

Discussion of Results.—The action of pituitrin was observed in twenty experiments upon six rabbits after removal of the right superior cervical sympathetic ganglion, and degeneration of the post-ganglionic nerve fibres. Two examples are described in Experiments 1 and 2.

Dilatation of the pupil was present in eighteen experiments, while constriction occurred in one case, and in one instance the pupil first contracted and then dilated to the dimensions at the beginning of the experiment—Table I, left side.

The percentage of dilatations is, therefore, 90, which is slightly less than the 93.75 per cent. found on the control, or normal side; while a dilatation occurred in every instance in the decentralised dilator.

The average dilatation was 0.86 mm. in the vertical meridian, and 0.77 mm. in the horizontal meridian, which is greater than the 0.72 and 0.62 mm. observed on the normal side. The greatest dilatation was 1.5 mm. in each diameter, while the least dilatation was 0.25 mm.

The same changes in contour of the pupil were observed on the deganglionated side as on the control side. The similarity of results observed in the two pupils is remarkable, notwithstanding

that eighteen of the experiments were alone carried out on both sides simultaneously, the only difference being the greater dimensions attained in the dilatation on the side without the ganglion.

The one occasion upon which constriction occurred was in the same experiment as that in which it occurred on the normal side, and the remarks which have been made above apply equally to it except that the pupil of the deganglionated side began slightly larger than upon the other four occasions, and contracted 0·75 × 1 mm.

The case which contracted and then dilated occurred in a different rabbit, number 2, to the similar phenomenon found on the normal side. It will be seen from Table I that on the other occasions both pupils dilated.

III.—The Decentralised Dilator Pupillae

Six experiments were performed on two rabbits in which the right sympathetic nerve had been cut in the neck below the superior cervical ganglion. The cut ends of the nerve were separated and the superior sympathetic ganglion was left *in situ*.

In each case, there was a dilatation of the pupil, the average dilatation was 0·79 mm. in the vertical, and 0·66 mm. in the horizontal diameter, Table I. These figures show a less dilatation than in the deganglionated dilator, but they are slightly greater than the average for the normal pupil, i.e., they lie between the dilatation of the normal pupil and the dilatation in the dilator with the ganglion excised.

Pituitrin acts like adrenalin in stimulating the dilator pupillae and does so more markedly in the deganglionated and the decentralised eye. But whether it acts upon the peripheral plexus or directly upon the muscle is not indicated.

IV.—The Deganglionated Sphincter Pupillae

Historical Summary.—While there is no record of previous work on the action of hypophysin on the deganglionated sphincter pupillae, Joseph[48] investigated the action of adrenalin. He stated that the irritability of the pupil of the cat to adrenalin was three to twenty times greater after excision of the ciliary ganglion than in the normal iris. He ([49]) also demonstrated that adrenalin produced a relaxation of isolated strips of the sphincter pupillae and drew the conclusion that the cervical sympathetic supplies inhibitor nerve fibres to that muscle.

Reference must be made again to the effect of intravenous injection of pituitrin in the *résumé* in the section on hypophysin and the normal iris. All previous workers found a constriction of the pupil in the normal iris.

Discussion of Results.—(*a*) *Local Application.*—Four experiments were performed in two rabbits in which the right ciliary ganglion and accessory ganglia had been removed, and probably some of the long ciliary nerves had been cut. Anderson[50] found that the injury to the long ciliary nerves made no difference in his results with pilocarpin. The left side was kept for the control. Two drops of pituitrin were instilled in the usual manner each quarter of an hour until six drops had been applied. A dilatation of the pupil occurred in each instance. Table I.—The average dilatation was 0.81 × 0.75 mm. which is greater than in the normal eye, and almost identical with the 0.86 × 0.77 mm. observed after removal of the superior cervical ganglion. The pupil in these rabbits was very sensitive to adrenalin, confirming Joseph[47], but did not appear to have been more sensitive to pituitrin, as compared with the normal iris, than in the pupil after removal of the superior cervical ganglion. My experiments, therefore, indicate that the local effect of pituitrin upon the pupil is increased by about the same proportion by removal of either the ciliary and accessory ganglia, or of the superior cervical ganglion.

(*b*) *Intravenous Injection.*—Two experiments were performed by intravenous injection of 1 cc. of pituitrin into the auricular vein of another rabbit in which the right ciliary ganglion and accessory ganglia had been removed. The experiments were undertaken on the 19th and 26th days after the operation. In the first experiment the deganglionated pupil dilated 1 × 1 mm. within five minutes, while the left, or control, pupil dilated immediately after the injection and then became constricted by 1 × 1 mm. The dilatation in the right pupil was reduced to 0.25 × 0.25 mm. at the end of an hour, while the normal pupil returned to its original dimensions. In the second experiment the deganglionated right pupil became dilated to 0.5 × by 0.5 mm. at the end of five minutes, while the control pupil dilated immediately after the injection and then became constricted by 0.75 × 0.75 mm. At the end of an hour the right pupil was only 0.25 × 0.25 mm. larger than at the beginning, while the left normal pupil had also dilated sometime earlier to 0.5 × 0.5 mm. and had remained dilated.

These results indicate that after removal of the ciliary and accessory ganglia the intravenous injection of pituitrin produces a dilatation of the pupil on the deganglionated side, while the normal pupil gives the constriction found by previous observers which may be both preceded and succeeded by dilatation.

V.—The Decentralised Sphincter Pupillae

Discussion of Results.—(*a*) *Local Application.*—Four experiments were also undertaken on two rabbits, in which the right pre-ganglionic

fibres of the sphincter pupillae were cut immediately above the ciliary ganglion without disturbing, in so far as possible, the vascular supply of the ganglion.

The pituitrin was instilled in the operated eye, and in the normal eye in the customary manner. The dilatation of the pupil occurred in each case. Table I.—The average dilatation was 0.62 × 0.56 mm., which is smaller than the average of 0.72 × 0.62 mm., found in the normal pupil. It is, therefore, the smallest average obtained in the whole series of pituitrin experiments.

(*b*) *Intravenous Injections.*—Two experiments were performed in one of the rabbits with the intravenous injection of 1 c.c. pituitrin, when a dilatation was found on the decentralised side in both instances. In the first experiment, the dilatation reached 1 × 1 mm., and in the second, 0.75 × 0.75 mm. at the end of from five to 10 minutes, but had partly passed off in the first by the end of an hour, when it was 0.5 × 0.5 mm., while in the second experiment the pupil remained of the same dilatation at the end of an hour as it was five minutes after the injection. In both experiments, the normal pupil dilated immediately after the injection, and then became constricted. By five minutes in the first, it measured 1 × 1 mm. of constriction, and in the second, 0.5 × 0.5 mm. By the end of an hour, the constriction had passed off and given place to a dilatation of 0.25 × 0.25 mm. in the first experiment, and 1.25 × 1.25 mm. in the second.

These results show that the intravenous injection of pituitrin does not produce a constriction of the pupil after interruption of the preganglionic fibres of the ciliary ganglion, while the constriction observed on the normal side within five minutes of the injection gives place, also after a short interval, to a dilatation. They therefore prove that a dilatation of the pupil is a local action of pituitrin which is increased by decentralising and more markedly by deganglionising, and may act either on the persisting peripheral plexus or upon the muscle directly. In this way it resembles the action of adrenalin.

The possibility of abolishing the action of pituitrin by the previous administration of ergotoxin was considered. I found that ergotoxin widely dilated the pupil in the rabbit, an observation confirmed by Githens[42].

VI.—The Deganglionated Dilator and Sphincter Pupillae

(*a*) *Local Application.*—The experiments have been repeated upon four rabbits in which the right ciliary ganglion and accessory ganglia and the superior right cervical sympathetic ganglion had been excised.

The accompanying Table gives the results of eight experiments on four rabbits in the right eye, the other eye being kept as a normal control iris. The average dilatation was 0.94 × 0.96, which is

larger than any of the dilatations obtained in the previous experiments.

If the excess of the average deganglionated dilator dilatations over the average normal dilatation is added to the similar average excess in the case of the deganglionated sphincter muscle, then the result comes out almost equal to the figures of this last experiment.

The numbers are small to make a definite statement, but the result is that with the doubly deganglionated iris, the pupil dilates more than after deganglionation of the sphincter or of the dilator pupillae muscle separately.

TABLE II

Deganglionated Dilator and Sphincter

Right Eye.

	Vert.	Horiz.
Rabbit 1.	1	1.25
	0.75	1
2.	1	1.25
	0.75	1
3.	0.75	0.5
	1	1
4.	1.5	1.25
	0.75	0.5
Average	0.94	0.96

(*b*) *Intravenous Injection.*—In each of these rabbits the intravenous injection of pituitrin 1 c.c. was given, with the result that the normal pupil contracted while the doubly deganglionated pupil dilated. This effect was all the more noticeable because the left normal pupil had been the larger before the injection while with the injection it became the smaller. The first phase is sometimes a momentary dilatation of the normal pupil associated probably with the excitement, as the animal often struggles at this point. This is succeeded by a constriction which on one occasion contracted 3.25 mm. in the vertical, and 4 mm. in the horizontal, but in this instance the normal eye was facing the window with good daylight, while the right doubly deganglionated eye showed a dilatation which after a period of ten to fifteen minutes reached 0.75 × 0.75 mm.

On the normal side the constriction passed off in the course of twenty minutes, and was followed by a dilatation to a size larger than at the outset of the experiment. In this case the pupil ultimately reached in the course of three-quarters of an hour 0.75 × 1.25, a dilatation larger than the original dimensions.

Conclusions

Hypophysin (pituitrin, Parke, Davis & Co.) when applied to the eye of the rabbit by instillation, produces a mydriasis in about 94 per cent. of the experiments, although it is necessary in some cases to repeat the application several times. The effect is increased by decentralisation and still more by deganglionation of the dilator pupillae or of the sphincter pupillae; and most markedly by deganglionation of both dilator and sphincter pupillae.

When hypophysin is administered by intravenous injection, the local mydriatic effect is lost if the blood pressure is raised, when a miosis occurs, due to central stimulation of the third cranial nerve, which relaxes with the return of the blood pressure to normal, as shown for adrenalin in the dog by Elliott,[46] and is followed generally by a slight dilatation. The constriction of the pupil may be preceded by a brief dilatation due to excitement at the moment of injection.

When the third cranial nerve is interrupted by section above the ciliary ganglion or by excision of the ciliary ganglion and accessory ganglia, the pupil dilates within a few minutes of the injection and generally returns to its normal size within an hour.

Hypophysin acts on the same structure as adrenalin, and since adrenalin acts on the neuro-myal junctions, hypophysin must also act there. Since deganglionation does not cause degeneration of the terminal plexus (8), the presumption is that both drugs act upon this.

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A METHOD OF IRIDOTOMY

BY

M. S. MAYOU,

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THE following method of performing iridotomy has been practised by the author for the last fifteen years. Taken as a whole he has found it more successful than any other method which he has tried, as it yields a much larger opening, and is therefore less liable to be closed by subsequent inflammatory exudation. He makes no claim of originality for the operation; indeed, he has seen the operation performed by other ophthalmic surgeons, but does not know who first performed it.* The method does not seem to be generally known.

The operation is usually performed under a general anaesthetic, but this is not essential.

First step. The surgeon stands facing the patient on the same

* Since writing the above, I find in the *Report* of the Ophthalmic Department of King's College Hospital, Vol. VII., 1900, a case recorded in which the operation was done by Mr. MacHardy.—M.S.M.

side as the eye to be operated on. A long, narrow, bent broad cutting needle is passed into the anterior chamber from the limbus downwards and inwards, and is driven directly through the iris and underlying capsule. The needle is then made to pass in an upward and outward direction behind the iris into the pupillary area above, or if no pupil be present, again through the iris (Fig. 1.) The bent broad needle is made to cut laterally by slightly deflecting the handle so as to produce a band of iris and capsule; the cutting needle is then withdrawn. Care should be taken as far as possible to prevent the loss of aqueous.

Second step. A Tyrrell's hook, bent to the correct angle, is

FIG. 1.

FIG. 2.

passed beneath the band (Fig. 2), which is drawn into the wound and removed with iris scissors. A large opening is thus obtained with a minimum amount of trauma. If the hook should slip, the band may be seized with iris forceps, withdrawn from the wound, and removed.

The operation has the advantage that if it fails from blocking of the opening by inflammatory tissue, a tight fibrous band is formed between the old wound above and the new wound below, and this can subsequently be divided with a pair of fine iris scissors through a lateral incision at the limbus; the tension of the band will cause it to spring apart when divided.

THE POSITION OF THE AXIS IN ASTIGMATISM, AND THE AMOUNT OF THE ASTIGMATIC ERROR FROM AN ANALYSIS OF FOUR THOUSAND PRESCRIPTIONS

BY

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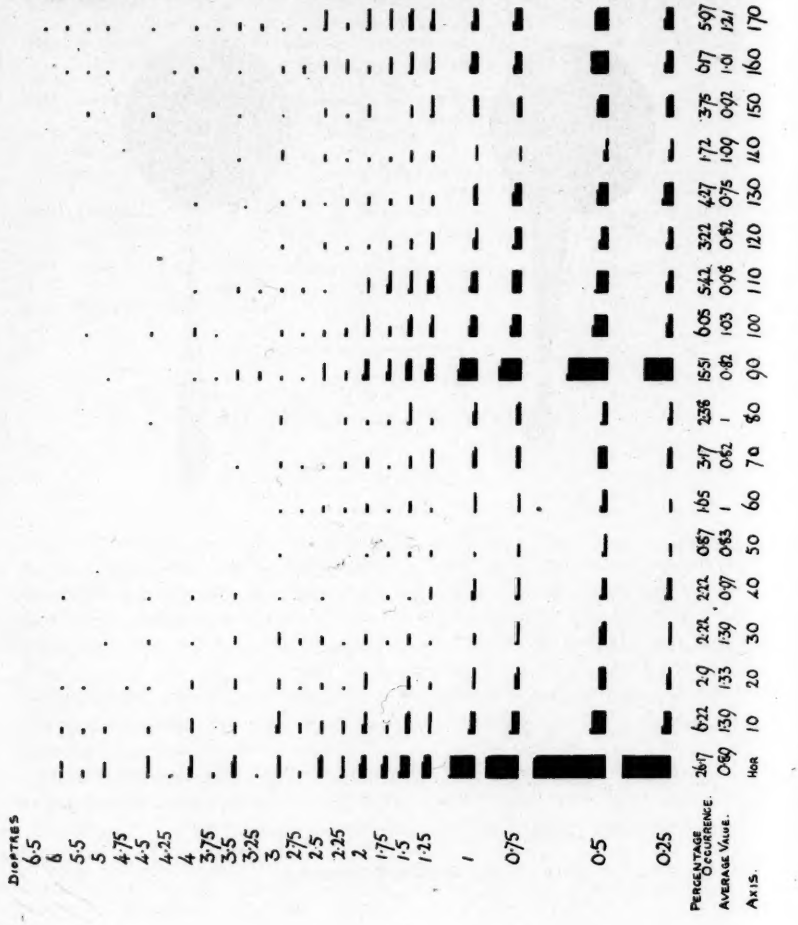
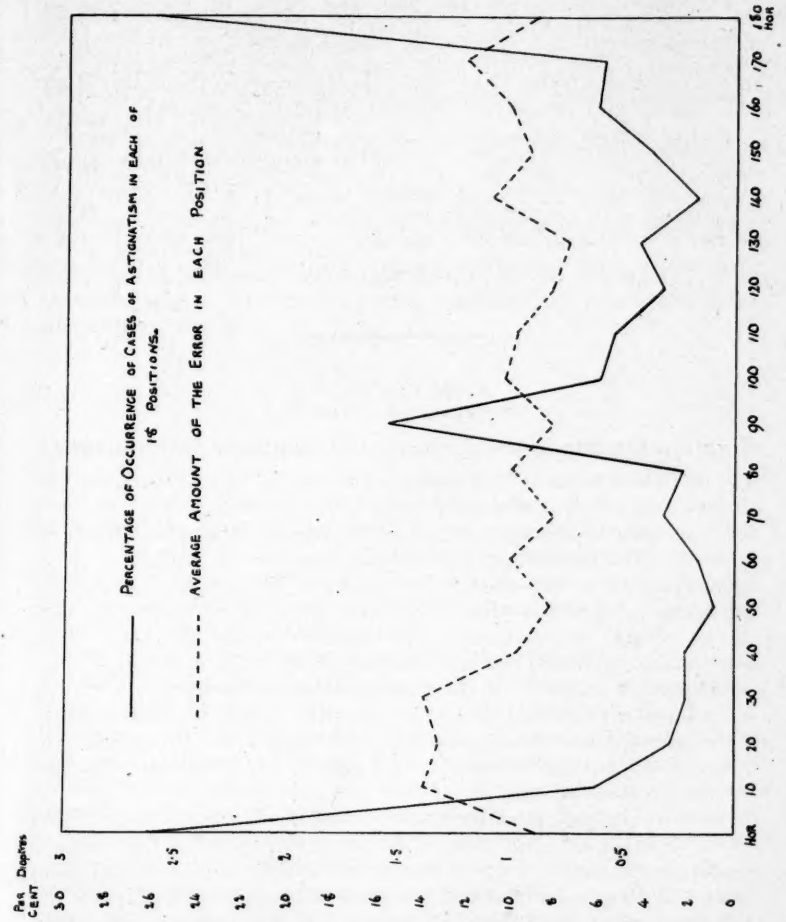
LONDON.

WHILE working, in 1918, among Canadian troops, I noticed on one occasion that seven soldiers in succession had astigmatism "against the rule." In order to satisfy my curiosity as to whether



astigmatism "against the rule" was unusually frequent among Canadians, I made an analysis of all the refractions that I had determined of Canadian soldiers and compared the results with those of a similar number from Imperial troops. The results from


PERCENTAGE OF OCCURRENCE OF CASES OF ASTIGMATISM IN EACH OF 18 POSITIONS.
AVERAGE AMOUNT OF THE ERROR IN EACH POSITION
PER CENT
Dioptres
HOR.
HOR.

each source closely agreed; but as the total number of refractions was less than 500, I did not feel confident that the statistics might not be vitiated by "imperfect sampling."

On returning to London I therefore made an analysis of 4,000 refractions from my father's patients and my own.

I was only anxious to determine the relationship of the axis to the mid-line of the face, and therefore added the refractions of the left eye to those of the right. The results may be seen in Diagrams 1 and 2. All astigmatism is expressed in terms of *minus* cylinders.

Diagram 1 represents the axis and value of each cylinder. Those in the first column, marked horizontal, include also those lying at 5° in the Right eye and at 175° in the Left; while those in the column marked 170 include also those at 175° in the Right eye, and 5° and 10° in the Left eye (Standard Notation).

At the bottom of Diagram 1 will be found the percentage frequency of the occurrence of the astigmatism in each position and the average amount of the astigmatic error in dioptres.

Diagram 2 is a graphic representation of these results. It will be noticed that astigmatism "against the rule" is of more frequent occurrence than is often taught, and that the curve is not symmetrical.

ANNOTATIONS

Fixation Abscess in the Treatment of Sympathetic Ophthalmitis

The treatment of sympathetic ophthalmitis by any or all of the usual methods is sufficiently unsatisfactory to justify the trial of any therapeutic measures which offer even a reasonable chance of success. The formation of a fixation abscess—a method of treatment originally introduced by Pochier (of Lyons) in cases of puerperal septicaemia—has been employed in various other diseases of a severe inflammatory and usually septic character, e.g., pneumonia. Within the last five years Van Lint, of Brussels*, has adopted this method in the treatment of severe intractable iridochoroiditis with results which he describes as "always favourable." Subsequently, in collaboration with H. Coppez, he submitted four cases of sympathetic disease to this plan of treatment and obtained a "remarkable success."

In two of his cases the treatment was adopted at the time of excision of the exciting eye; in the other two several weeks had elapsed since the enucleation, which had failed to exert any beneficial effect upon the progress of the disease in the fellow eye. In all four the inflammatory phenomena underwent rapid amelioration, with diminution of the circumcorneal injection, clearing of the media, and dilatation of the pupil.

The technique is simple and the discomfort to the patient not excessive. One cubic centimetre of pure oil of turpentine is

* *Archives d'Ophtalmologie*, July-August, 1919, p. 621.

injected into the subcutaneous tissue in the flank. This is followed in a few days by the development of an abscess filled with aseptic pus, and usually accompanied by slight pyrexia. About the seventh day the abscess is incised and the contents evacuated. The whole procedure is conducted under strict aseptic precautions; the contents of the abscess should be sterile. In young or weakly patients the injection may be reduced to half a cubic centimetre of turpentine, given alone, or with the addition of an equal quantity of olive oil.

The advocates of this addition to the "therapeutic arsenal of ophthalmology" consider it a very valuable resource in iridochoroiditis and sympathetic ophthalmitis. "It does not always result in a definite cure, but in every instance it has led to an arrest in the progress of the malady."

With this emphatic statement before us the desirability of an extended trial of this method in the treatment of destructive forms of uveitis is obvious.

Miners' Nystagmus

The incidence of miners' nystagmus, the commonest of all industrial diseases, has shown a marked increase from 1908, the year after the disease was scheduled, when 460 men received compensation, to 1913, the last year of published statistics, when 4,551 men were disabled. Llewellyn, in a recent lecture, estimated that, including incipient cases and men who had commuted, 6,000 men have been disabled yearly since 1913, and that the cost to the country has been £1,000,000 a year.

The opinion, expressed by the Oxford Ophthalmological Congress of 1912, that deficient illumination is the chief factor in the disease is now held by most observers, with the notable exception of Dransart. The holing or undercutting of the coal has not the importance alleged by Snell, who thought that the disease was almost entirely confined to holers; in fact, 50 per cent of Llewellyn's 1,400 consecutive cases had done no holing. Errors of refraction, accidents, and ill-health appear to be predisposing factors.

Two distinct varieties of the disease are described; the latent, in which symptoms are absent, and the manifest in which some incapacity exists. The chief symptoms are loss of sight, especially at night time, headache, dread of light, giddiness on stooping, and movement of the eyes. It is important to realize that the nervous system is profoundly affected in the disease. The characteristic physical sign of nystagmus is often masked by clonic spasm of the eyelids.

Miners' nystagmus is not readily cured, and the proportion of

men who return permanently to work underground does not exceed twenty-five per cent. Many men reach a state of "equilibrium" and continue to work for years after the onset of the disease. Remedy lies in prevention, and it has been suggested that the illumination of the candle pit, where nystagmus is rare, should be taken as a standard for the safety lamp pit.

The question of improvements in the miners' safety lamp is arousing great interest at the present time, and a Home Office Committee is dealing with the subject.

ABSTRACTS

I—ORBITAL ANAPLEROSIS

Lagrange (Bordeaux).—Orbital anaplerosis. (De l'anaplérose orbitaire) *Arch. d'Ophtal.*, March-April, 1919.

Under the term anaplerosis (derived from the Greek ἀναπληρόω, to fill up), Lagrange describes a new procedure designed, like many other operations introduced during the last forty years, to provide a substitute for the enucleated eyeball, and to form a satisfactory stump on which an artificial eye may rest, and from which the latter may derive movement. The author reviews briefly the methods which have hitherto been employed; the pseudo-plastic devices, such as Mules's operation, the heteroplastic grafts, *e.g.*, rabbit's eyes, and more recently homoplastic grafts of skin and fat, and of cartilage. None of these methods has proved really satisfactory; the best aesthetic results have been obtained in cases in which abscission of the anterior parts of the eyeball has been performed and this procedure, the writer recognizes, is suitable for a very limited number. The operation now described by Lagrange seems to the reviewer to be based on sound principles and to give greater promise of success in filling up the cavity of the orbit than any others with which he is acquainted. Unfortunately, the procedure is one which no written description, unaided by diagrams, will portray adequately and intelligibly. Those who are interested should study the original article.

The operation is suitable for cases of immediate enucleation, or for those in which the eyeball has been removed previously. The technique, though lengthy, is simple, and is given in detail by the writer and illustrated by numerous helpful diagrams. It consists essentially in obtaining a pedicled flap of connective tissue and fat from the region adjoining the external angle of the orbit. This flap is exposed by a T-shaped incision through the skin. In the space

thus formed an oval-shaped flap, about 7 cm. long, 6 cm. broad, and 2 mm. thick, is dissected up from the distal end. The pedicle is attached to the skin and soft parts at the internal angle of the orbit. This flap is introduced into the capsule of Tenon under the tissues at the orbital angle, and entirely subconjunctivally. When the flap has been drawn into Tenon's capsule, it has to be attached to the cut ends of the recti muscles; the technique of this stage of the operation should be studied by the aid of the diagram; the plan of attaching the muscles to the flap has been devised with the view of placing the flap as high in the orbit as possible, in order that the hollow behind the upper lid (so noticeable a deformity in most cases after enucleation) may be rendered less conspicuous.

In cases in which the eyeball has been removed at a former date, the latter part of the operation is varied, it being impossible to attach the flap to the recti tendons. In such cases the tip is sutured to the upper lid close to the inner canthus. The conjunctiva in this group of cases should not be incised anteriorly, the preparation of a bed for the flap and its introduction from the temporal angle being completed subconjunctivally. It seems scarcely necessary to add, in the words of the author, that such an operation is suitable only for cases in which the orbit is free from infection of any kind.

J. B. LAWFORD.

II—ICTERO-HAEMORRHAGIC SPIROCHAETOSIS

(1) **Weekers, L. — Recurrent iritis in spirochaetosis ictero-haemorrhagica. (Iritis récidivante dans la spirochétose ictéro-hémorrhagique.)** *Arch. d'Ophtal.* Nov.-Dec., 1918.

(1) In the Sept.-Oct. number of the *Archives d'Ophtalmologie*, Weekers and Firket recorded a series of observations on the ocular complications of spirochaetosis. **Weekers** now publishes a supplementary paper containing notes of one case in which the iritis occurring during the acute stage of the disease, recurred on three occasions during the nine months after convalescence was established. The recurrences were severe but cleared up without any permanent damage to sight. Other causes for iritis, such as syphilis, were excluded.

J. B. LAWFORD.

(2) **Moret (Chef du service d'ophtalmologie à l'Hôpital Militaire belge de Bourbourg). — Ocular troubles in ictero-haemorrhagic spirochaetosis. (Troubles oculaires dans la spirochétose ictéro-hémorragique.)** *La Clin. Ophtal.*, January, 1919. (From *Archiv Med. belges*, December, 1919)

(2) This article by **Moret** is of much interest and well written. The author's own "Conclusions," slightly amplified, will form an excellent abstract:

1. Serious cases of ictero-haemorrhagic spirochaetosis are accompanied by various troubles of the visual apparatus. (In the slight forms the author has not found anything of ophthalmological interest).

2. The affection is to be divided into two periods, namely, the acute or congestive, and the period of decline—the anaemic period. Different troubles having different causes correspond to these two periods.

3. During the congestive period:

(*a*) Vaso-motor affections of the external and sometimes of the internal eye membranes.

Conjunctival congestion is an early symptom, and is sometimes accompanied by a corresponding congestion of the uveal tract and hyperaemia of the deep membranes. (Extreme redness of the discs as if there were a commencing papillitis.)

This vaso-dilatation is not inflammatory in origin. It appears to to be due to a marked interference with the angiotonic function of the suprarenals. (As an example of the non-inflammatory nature of this congestion may be mentioned the fact that the great conjunctival congestion is entirely unaccompanied by discharge.)

(*b*) Haemorrhages of the external and sometimes of the deep membranes of the eye. These haemorrhages are small, and in the author's opinion are due, not to rupture of blood-vessels, but to the fluid state of the blood and the dilated condition of the capillary vessels—in fact, diapedesis.)

(*c*) The ictero-haemorrhagic spirochaete may locate itself in the iris and give rise to iritis. (Thus this organism can bring about an inflammation of the iris through the blood in the same manner as the spirochaeta pallida. But in most cases there is not iritis but merely congestion of the iris of vaso-motor origin. This is shown by the behaviour of the iris to vaso-constrictor mydriatics like adrenalin and cocain, on the one hand, and to atropin and homatropin, on the other. The pupil does not dilate to the former but dilates to the latter.

4. During the period of anaemia there are subjective symptoms such as are commonly observed in profound anaemias; such are asthenopia and muscae volitantes. Ophthalmoscopically there is a certain degree of retinal anaemia. In some cases, however, there is an appearance of neuro-retinitis out of all comparison with symptoms. (The visual acuity is normal, there are no scotomata and no dyschromatopsia.) A similar state of affairs is known to occur in other essential or symptomatic anaemias.

ERNEST THOMSON.

III.—OCULAR SPARGANOSIS

Motais, François. — Ocular sparganosis. (La sparganose oculaire.) *Arch. d'Ophtal*, September-October, 1918.

The title "Ocular Sparganosis" is used by **Motais** to designate the invasion of the cellular tissue of the orbit of the eyelids by the sparganum Mansoni, the larval form of one of the cestoda.

Sparganum was discovered by Manson, in 1882, in the pleura and peritoneum of a Chinese. Since that date the larva has been identified by Scheube, Ijima, Murata in Japan, by Sambon in East Africa, by Daniels in British Guiana, by Casaux in Tonquin, and by Garde and Rongier in Annam.

Motais now publishes a case under his observation, in which the larva was removed from the eyelid of a child. The parasite has been found once in serous membranes, four times in the genito-urinary system, twice in the limbs, and seven times in the annexes of the eye.

The adult form, hitherto unidentified, is classed among the Dibothriocephalidae.

The larva is a small flat riband-like worm, a few centimetres in length. It has an enlarged oval head (see sketch in Motais' paper) 3 mm. long by 2·5 mm. wide; the top shows a median transverse invagination bordered by two ridges. The body is 1·7 mm. in width, and its extremity is rather ragged. The head and the anterior part of the body are transversely but irregularly striated.

Henry and Bauche have on several occasions found the sparganum in the connective tissue of pigs in Annam. Motais has been able to examine one of their specimens, and believes it to be exactly similar to the larva removed from his patient. De Ratz, of Buda-Pesth, has found similar larvae in the flesh of pigs in Hungary.

Motais' patient was a boy, aged 11, who was born and had always lived in Hué (Annam). For about a year the parents had noticed occasional redness of the eyes and oedema of the eyelids. A small swelling on the left upper lid had appeared at the beginning of the trouble, and had slowly increased in size. When seen, there was a deep mobile elastic tumour, the size of a haricot bean, at the upper outer end of the upper lid. This was easily removed through the skin; it was situated in the connective tissue and in contact with the palpebral conjunctiva. The larva was found in a small fluid-containing cavity in the mass. The tumour was composed of fairly dense vascular connective tissue, surrounded by fat.

J. B. LAWFORD.

IV.—GLAUCOMA AND GLAUCOMA OPERATIONS

(1) **Stirling, J. W. (Montreal).—Some notes on the blockage of the trephine opening after the Elliot operation.** *Arch. of Ophthal.*, Vol. XLVI, No. 4, p. 352, 1917.

(1) **Stirling** opens his paper by saying: "The blockage of the trephine opening as a sequel to the Elliot operation for glaucoma is not of common occurrence. In forty-six operations of my own it developed in three." In addition he has the notes of the anatomical examination of an eye operated on by another surgeon. In three out of the four cases, the glaucoma was of long standing, and was congestive in type. In all three early blockage occurred. In the fourth, the filling up of the hole was delayed nearly a year, and in this one the hyperplasia of the conjunctival and episcleral tissue was apparently the main cause of the blocking. Stirling thinks the stitch may have been responsible. In the remaining cases the hyperplastic tissue was apparently of uveal origin. Stirling says: "the cause of the blocking has hence to be sought in the origin of the inflammation of the iris, associated with that of the subconjunctival tissue." He leans to the view that the condition is an auto-toxaemic one, lighted up by the operative traumatism, and is not due to a germ infection. Anyone who has met cases of this kind will readily recognize the type of eye that Stirling describes. One knows well, before one operates, that there is a danger of the filling up of the trephine hole at an early date, and the question rises in one's mind, how far these are truly congestive cases, and whether a septic element is not present in them. Stirling prefers to talk of them as auto-toxaemic. It matters little how we label them, so long as we can recognize them, but the reviewer believes that time will decide in favour of their origin being septic in nature, the septic element being present before operation, and not being introduced by it. In the latter respect he cordially agrees with Stirling. In such cases it matters little what operation is employed, the resulting failure will be the same in all alike.

R. H. ELLIOT.

(2) **Ewing, A. E. (St. Louis).—Post-ciliary scleral trephining for glaucoma,** *Amer. Jl. of. Ophthal.*, July, 1917.

(2) **Ewing** relates at considerable length two cases of glaucoma, one with almost no vision and tension Schiötz 50, the other with vision 20/15 and tension Schiötz 45. In each of these cases Ewing performed Argyll Robertson's operation of trephining behind the region of the ciliary body. The site chosen was between the superior and external recti, 7 mm. and 9 mm. behind the corneal margin respectively in the two cases. Conjunctival flaps of 8 mm.

raised from below were employed. Ewing has been satisfied with the results obtained, but it will be generally admitted that no great hopes can justifiably be based on only two operations. One feels that the writer may, after a more extended trial, be less satisfied than he is at present. This is what he says about the results in these two cases. "From the standpoint of the ideal the operations are not wholly successful, because the tension in neither of the eyes is normal. From the practical standpoint the condition in the advanced glaucomatous eye is entirely satisfactory, the globe having become quiet and the pain having been relieved. The tension in the second case is reduced about one-third. This is a material gain." For the author's arguments and views in general the reader is referred to the original.

ERNEST THOMSON.

(3) **Clapp, C. A. (Baltimore).—Corneo-scleral trephining.** *Amer. Jl. of Ophthal.*, Series 3, Vol. I, No. 2, February, 1918.

(3) It is not often in these days that one comes across a wholesale denunciation of the trephine operation. **Clapp** as the result of five cases operated on unsuccessfully, one of them by Colonel Elliot himself, comes to these conclusions: (1) The corneo-scleral trephine operation for glaucoma has late results which may develop even years after the operation. (2) Rarely if ever should it be the operation of choice. (3) It should be tried where iridectomy has failed. (4) Some reports in cases of buphthalmos would seem to warrant further trial in this condition. The results of the five cases may be summarized as follows: (1) Neither permanent lowering of tension nor restoration of vision. (2) Late infection after one year. (3) Simple chronic glaucoma became fulminating on third day after operation. (4) Col. Elliot's case. Operation on both eyes. Vision of one eye before operation was 20/20, after operation it was 20/100 and remained so four years later. (5) Iritis five months after operation, subsequent blindness.

ERNEST THOMSON.

(4) **Morax, V. (Paris.)—Clinical notes on some early atypical signs of subacute glaucoma.** *Ann. d'Oculist*, Vol. CLV, February, 1918.

(4) In this short paper **Morax** points out that we are much beyond the stage when glaucoma is diagnosed from the nasal field retraction and the disc cupping, both of which can come only after, say, six to twelve months of hypertension, but he does not wish to enlarge on the well-known classical signs but draws attention to *orbito-facial pain* like a deep bone pain, giving rise to suspicions of a sinus or periosteal affection, and to *watering*. The cases he discusses are those where one or both of these phenomena were alone present, coupled solely with tonometric changes and relieved

by pilocarpin. He advocates the constant use of the tonometer in cases where ocular, cephalic, or facial pains are not clearly explicable, and this would, he affirms, do away with many mistakes. Two cases with two-year old and six-months old orbito-facial pains had gone to the oto-rhinologist for relief whereas there was no sinus affection but a need for eserin. In this connection it is noteworthy that in the days of Demours glaucoma was regarded as an inflammation of the orbital periosteum and of the frontal sinus mucous membrane. Short notes are given of four cases, viz. man of 43 and one of 50, and woman of 46 and one of 35, in whom only these phenomena were noticed and in whom eserin or pilocarpin gave complete relief.

W. C. SOUTER.

(5) **Lamb, Robert Scott (Washington, D.C.)—A theory as to the origin of glaucoma.** *Amer. Jl. of Ophthal.*, Series 3, Vol. I, No. 3, March, 1918.

(5) This article is mainly of a speculative character. The author suggests that acute inflammatory glaucoma is probably the result of a sudden imperative demand upon the adrenals under conditions in which the demand cannot be fully met, with the result that there is a "precipitate lowering of sympathetic tone" which throws the balance under the control of the vagus, "in the presence of predisposing factors, such as high hyperopic eyeballs and other anatomic abnormalities." The result of vagus control is the "venous congestion and marked turgescence which is so commonly seen in the later stages of an acute inflammatory glaucoma." The obvious indications are the use of pilocarpin and adrenalin, the former "acting through the vagus, will give us sufficient relaxation to permit the re-establishment of the circulation, more normal tone and a gradual restoration of the local structures to size and condition approaching that which immediately preceded the acute attack." The author states that this method of treatment has been tried out in thirteen cases and has been successful in each case in restoring the eye to a relatively normal condition, so that the dangers from a subsequent operation to increase the drainage, were undoubtedly very much lessened.

ERNEST THOMSON.

(6) **Colombo, Gianluigi (The Ophthalmic Clinic of the University of Parma).—On the importance of irido-ciliary entanglement in sclero-corneal trephining (Elliot) for glaucoma. (Sull importanza dell'impegno irido-ciliare nella trapanazione sclero-corneale (Elliot) contra il glaucoma.)** *Arch. di Ottal.*, March-August, 1918.

(6) **Colombo** divides his interesting and suggestive paper into two parts. The first deals with his experimental work in which he trephined a number of rabbits' eyes, and after excision at various

later dates examined them microscopically. The trephine employed was 1.5 mm. in diameter, and in all a peripheral iridectomy, leaving the sphincter untouched, was performed. The trephine hole was made well forward to avoid injury to the ciliary body. The intraocular pressure was always considerably lower after the operation, and remained so up to four months (the latest period at which the eyes were removed). A careful description of the microscopical anatomy of the eyes is given, and illustrated by three excellent plates. The most important point found in practically all the specimens, was that the ciliary body had been dragged forward, and was implicated in the scar. Clinically there was no evidence of this to be seen after careful examination. Colombo rightly points out that experiments on an eye such as that of the rabbit are not necessarily conclusive evidence that the same results happen in the human eye.

In the second part he discusses the clinical work of other authors, as well as the bearing of his experimental work on the results obtained. He notes that Meller, Sattler, Di Marzio, and Guglianetti had expressed surprise at finding an irido-ciliary entanglement in human eyes, in which they had no clinical evidence of its existence. He points out that in Elliot's operation the conditions favour the involvement of uveal tissue in the wound owing to the long period during which the anterior chamber remains empty. Colombo holds the opinion that a so-called filtering cicatrix does not occur in the absence of uveal tissue. He sums up the question thus: "Such a fistula is in all probability formed by the presence of a more or less considerable involvement of uveal tissue, such involvement being also concerned with the irido-cyclitis that so commonly follows the operation. To the presence of such a fistula the late cases of deep infection are due."

Colombo says nothing about the tendency to early appearance of lens opacity in trephined eyes, but his theory has, if correct, something suggestive in this connection as well. In his view the ideal operation must get some involvement of uveal tissue which need only be minimal and invisible to ordinary clinical examination.

E. E. H.

INJURIES OF THE EYE FROM HIGH VOLTAGE CURRENTS

Morax, V. (Paris).—Lesions of iris, ciliary body, and lens consecutive to discharge of high voltage currents. *Annal. d'Oculistique*, Vol. CLV., July, 1918.

Since the beginning of 1918 **Morax** had had the opportunity of watching three cases which presented points of medico-legal importance in view of changes in the eyes coming on after, and attributed to, exposure to high voltage currents or fulguration or electrocution, as he calls it. Even if it is admitted that late lens opacification can succeed such exposure, it is not, on the other hand, established that an iritis or iridocyclitis precedes or accompanies these lens changes. In the first case, Morax was inclined to suppose the extensive skin burns had been the entrance point of organisms which had reached the iris and ciliary body through the circulation and so caused the trouble, but since the first case he has altered his views somewhat.

His first case, a man of 51, on January 19, 1918, was working in a (step-down) transformer cage and had touched with the crown of his head a bar of the transformer carrying a triphase current of 12,000 volts, but exactly how it all happened no one can tell, for he merely recollects going into the cell and that, next day, he regained consciousness at the St. Louis Hospital. It was the arrest of the electric current in the factory which caused inquiry to be made, when the man was found unconscious with burns on vertex of head, wrists, and forearms. The man had had slight difficulty with vision beforehand but nothing more than would be accounted for by the four dioptres of hypermetropia present in each eye. He was kept in hospital for the burns, chiefly the scalp ones, and made no complaint of vision till February 16, when he spoke of difficulty in looking at the light, pains around left eye and a dimness of vision. The left eye showed iridocyclitis with "keratitis punctata," irregularity of pupil, and slight opacity of lens. One week later patient was transferred to the Eye Wards and atropin was begun: Right vision with +3D. sphere=5/15, Left vision with +3D. sphere =5/35; T.n.; deep scalp sloughs beginning to be shed off, other burns quite healed.

March 5.—Left eye better; transferred back.

April 10.—Seen again, this time for slight irritation and photophobia of right eye, cured with a few days of atropin.

May 31.—No irritative signs seen except with the corneal microscope, which showed some fine pigmented precipitates. Evident lens opacities in both, especially left. Vision in each eye as above. Tonometer 16 mm. Hg. each.

May (? June) 16.—Scalp barely healed yet. Pupils dilate fully and circularly after atropin, slight ectropion uveae, but no pigment on lens capsule and no "K.P." Lens opacity remains diffuse, and incomplete, with oblique illumination it appears as specks with here and there greyer points; with transmitted light one sees a series of ill-defined opacities, which allow of a good fundus view, fundus normal; the opacities are greater in left eye. R.V. with

+4D. sph.=5/15; L.V. with +5D. sph.=5/20. Thus the left eye began to show signs of iridocyclitis on the 28th day after exposure to the current, this disappeared in 17 days, then less marked similar changes appeared at the third month in the right eye. The iridocyclitic changes disappeared but lens opacities remained.

The second case is that of a man of 44 who had worn glasses for the past 12 years for high hypermetropia but had never noticed any difference between the two eyes. On March 18, 1918, he proceeded to clean some conductors for a current of 15,000 volts, believing the current to be off; a short circuit ensued and the man remembers nothing more. His fellow-workmen told him he lay unconscious for about 15 minutes. He had severe burns of right shoulder and left forearm—for these he attended the Lariboisiére as an outpatient.

Towards the end of May he developed discomfort in left eye, some peri-ocular pains, conjunctival hyperaemia, and almost simultaneously marked dimness of vision. These irritative phenomena did not last more than four to five days. Right eye also affected but no hyperaemia nor painful phenomena. Vision quite dim; clears up after some days. It is not till June 10 that he sees Morax. Lightning diagnosis of "cataract secondary to old irido-cyclitis." This shows under how false an aspect the electro-traumatic manifestations can present themselves. With the loupe (right eye) cornea clear, no conjunctival redness; anterior surface of iris normal; pupil edge has a slightly irregular pigmented piping, forming a small clump at one point. Lens shows small cortical opacities as dots or specks, but transparence of lens is only slightly interfered with. Right vision with + 4D. sph.=8/10; tonometer 18 mm. Hg. Deep parts of eye normal.

Left eye—cornea quite clear, complete cataract, edge of pupil slightly irregular with some synechiae and some ectropion uveae. On lens capsule a ring of pigmented dots is seen; no precipitates. Tonometer 18; V. = p. l., good projection. Urine healthy, Wassermann negative, forearm burn barely healed yet. Here iridocyclitis appeared two and a half months after the trauma and although not of long duration left traces.

Bistis's case had lens opacities starting one month after exposure, Terrien's three months, Bichelonne's seven months. This late change may be related to the tardy influence of the physical agent, for we know that the cutaneous lesions of the ultra-violet and the X-rays and of radium do not come on under identical conditions; the incubation can be more or less long and we know, for example, that it is at least eighteen days for X-rays. Possibly the late lens opacification is analogous to the tardy falling off of the hair after exposure to X-rays, but Morax does not feel inclined to say whether the lesions are due to the electric current itself or to the action of

the luminous rays which are always a marked feature of these short circuits.

Morax's conclusions are that after accidental electrocutions one can see supervene the signs of irido-ciliary inflammation preceding or accompanying the lens changes, the eyes being affected together or successively, the first signs being from ten days to three months after the accident. "The mere verification, or finding, of sequelae of iridocyclitis and of the lens lesions will not warrant the attribution of the ocular lesions to an endogenous infectious process." This, however, appears to be just the special difficulty of these two cases, notes of the third case not being given in the present paper. W. C. SOUTER.

BOOK NOTICES

Ferraris' Dioptric Instruments, being an elementary exposition of Gauss' Theory and its Applications. Translated by OSCAR FABER, D.Sc., O.B.E. Printed at the request of the Ministry of Munitions. Published by H.M. Stationery Office, 1919. Price 4s. net.

In 1840, Gauss published in the Royal Society of Göttingen, a paper entitled "Dioptric Researches," tracing the path of the central rays of light through a homocentric system of refracting media. His method, which expounded the theory of cardinal or fundamental points, greatly simplified the theory of dioptric instruments. Previous researches fell into two groups—those in which the thickness of lenses was neglected and those in which it was not. The first group, in the hands of Coles, Euler, Lagrange, and others, led to simple formulae and graphic constructions. The second resulted in complicated formulae, little or not at all adapted to geometrical constructions. There was a natural tendency therefore to neglect the thickness of lenses in cases where this procedure was unjustifiable. Gauss' theory permitted of equal simplicity and accuracy in all cases. Of the cardinal points the foci were previously known, and Möbius, in 1830, described the principal points, but Gauss first worked out in detail their properties. In 1845, Listing did the same service for the nodal points, which had been previously noticed by Biot.

Carl Friedrich Gauss was one of the greatest mathematicians of his age, but he wrote in a difficult though precise and exhaustive style. Like most of his work, his theory of cardinal points remained buried and unknown to any but a few mathematicians, who had little interest in the practical applications. The analytical proof of

the theory of Gauss was applied to the eye by Helmholtz in his "Physiological Optics" in 1856. The geometrical proofs of the theory were worked out by Clark Maxwell (1858), Neumann, and others; but simple though they were, they were not rendered generally available to opticians until Ferraris published his treatise in Italian in 1876. This book marked an epoch in the history of the subject, and was translated into German by Lippich in 1878. It does not redound to the credit of British enterprise that so important a work did not find a translator into English until the exigencies of the War made this step imperative. The book has at last appeared in English—translated from the German edition by the son of a Dane, and printed at the request of the Ministry of Munitions.

The title is not one to attract the ophthalmologist, but he would be grievously mistaken if he concluded that it makes no appeal to him. It contains the simplest exposition of the optical properties of the eye, lenses, and optical instruments which is available to anyone who wishes to obtain a sound knowledge of the mathematical principles of the subject. There is nothing in the book which cannot be easily mastered by any student who has the most elementary acquaintance with geometry. It contains no calculus and practically no trigonometry.

In the first part the fundamental properties of the dioptric system are considered in general. The formulae expressing the relationships between focal lengths and conjugate points, and so on, are in each case accompanied by clear geometrical constructions. Telescopic systems—without principal points—are also discussed in an elementary fashion.

In the second part applications are made to the eye, to lenses, to those systems of lenses which are most commonly used in the construction of instruments, and eventually to the instruments themselves, including a theory of compound instruments in which the expressions magnification, Ramsden circle, brightness, and field of vision are dealt with in general terms and expressed by formulae applicable to all instruments, microscopes as well as telescopes, by inserting the correct values of the symbols used.

Transactions of the Ophthalmological Society of the United Kingdom. Vol. XXXIX, 1919. London: J. & A. Churchill, 7, Great Marlborough Street, 1919. Price, 12s. 6d. net.

This substantial volume of 428 pages, includes the proceedings of the Ophthalmological Society of the United Kingdom during its Annual Congress in May, 1919, with the transactions of four of the five affiliated societies, namely, the Oxford Ophthalmological Congress, the Midland Ophthalmological Society, the Irish Ophthalmological Society, and the Ophthalmological Society of

Egypt. The whole forms a most representative volume. As regards the parent Society discussions upon the "Visual requirements of Aviators" and "Eyesight in connection with Education," together with the Bowman Lecture upon Plastic Operations upon the Orbit, etc., by V. Morax, are reported, together with papers and cases, as usual. It also includes the Doyne Memorial Lecture delivered by Mr. J. Herbert Parsons at Oxford in July last.

S. S.

La Médecine. January, 1920. Paris: 21, Bd. St. Germain.

Special attention may be directed to this number of our contemporary since it is devoted to ophthalmology and oto-laryngology. It is edited by Drs. A. Cantonnet and L. Baldenweck. both of Paris.

So far as ophthalmology is concerned, the former opens with a brief but interesting discussion, dealing with French eye work during the war, from 1914 to 1920. In the course of his paper, Cantonnet treats of many subjects, as, for example, ocular physiology, infections occurring in general infections (especially in war), injuries of the eye, radiography, sympathetic ophthalmitis, and such questions as aviation, treatment of the blind, and conservative surgery. Drs. Duverger and Mettey describe a method of muscular advancement whereby a result of 15° or 20° may be obtained by resecting about a centimeter of the body of the muscle. The tendinous insertion is not touched. In cases of purulent ophthalmia in adults, Aubauret advocates early and vigorous treatment on the classical lines, but when the cornea becomes involved recommends covering the cornea with the conjunctiva. According to Dr. R. de Saint-Martin's views, extirpation of the lacrymal sac must be undertaken in a systematic way in order to avoid haemorrhage, and should be followed by immediate suture. Drs. L. Vacher and M. Denis (Orleans) are of opinion that ablation of the lacrymal sac may be advantageously replaced by careful cauterization of the sac with chromic acid, of which they employ 1/3 c.c. of a 1/50 solution. In order to neutralize any escaping acid, one drop or two of pure oxygenated water should be placed in the conjunctival sac as the injection is made. Dr. Vinsonneau gives the common-sense advice that any medical man may remove a foreign body from the eye on the condition that it is placed superficially, and that it has not been present long. Dr. Chenet writes on hypopyon keratitis. Dr. Jeandelize (Nancy) advises that when an awkward socket remains after enucleation of the eye, the cavity be propressively dilated by the insertion of larger and larger vulcanite casts moulded for the purpose. Each is worn for from six to ten hours a day. The editor writes upon decompressive operations in chronic glaucoma,

and upon the advantages of iodine [equal parts of tincture iodine (codex), glycerine, and 90 per cent. alcohol according to Terrien] directly applied to the edges of the eyelids and the operative field. Provided the simple tincture is not older than a fortnight, he shows that it has no irritating action on the cornea. S. S.

NOTES

Deaths

THE deaths are announced of the following American ophthalmic surgeons: C. Brotemarkle, Salisbury, Md. Stephen O. Richey, Washington, D.C. James F. Smith, New York City. C. F. Sterling, Earrenton, Virginia, once Professor of the Eye and Ear at the University of Michigan. Francis Valk, aged 74, of New York City. Dr. Valk was for many years Professor of Ophthalmology in the New York Post-Graduate School.

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Appointments

CHARLES GOULDEN has been appointed assistant ophthalmic surgeon to the London Hospital.

W. Niccol has been appointed ophthalmic surgeon to the Gloucestershire Royal Infirmary and Eye Institution.

F. D. Blaxland has been appointed honorary ophthalmic surgeon to the Rookwood State Hospital and Asylum at Lidcombe, New South Wales.

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An X Ray Memorial

THERE is a movement on foot to establish a chair of X ray study at one of the universities and perhaps also an X Ray Research Institute in London, in memory of the late Sir J. Mackenzie Davidson.

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Moorfields Dinner

WE are now able to supplement the bare announcement of the Moorfields Annual Dinner for 1920, made in the last number. It will take place on Thursday, March 11th, at the Criterion Restaurant, at 7.30 p.m., Mr. William Lang in the Chair. Tickets 12s. 6d. each, exclusive of wine, may be obtained on application to Mr. Charles Goulden, 42, Welbeck Street, W.1.

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University of London

MR. H. L. EASON, C.B., C.M.G., has been elected by the Faculty of Medicine of the University of London as its representative upon the Senate. It is of interest to note that Mr. Eason has succeeded Sir E. Cooper Perry as Superintendent of Guy's Hospital, London.

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Royal Society

THE Rumford Medal for 1918 of the Royal Society has been awarded to Professor Charles Fabry and Dr. Alfred Parot (jointly) for their contributions to optics.

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British Ophthalmic Hospital at Jerusalem

The Great Priory of the Order of the Temple of England and Wales has contributed £1,657 13s. 8d. to the fund for reinstating the Ophthalmic Hospital at Jerusalem, destroyed by the Turks when they evacuated the Holy City.

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Ophthalmological Society of New South Wales

THE following office-bearers have been elected for 1920: *President*, Dr. Gordon McLeod; *Vice-President*, Dr. Guy Antill Pockley; *Secretary*, Dr. J. J. Kelly; *Members of Council*, Drs. R. H. Jones and E. A. D'Ombrain.

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Archives d'Ophtalmologie

WITH reference to a paragraph on p. 95 of the February number dealing with the *Archives d'Ophtalmologie*, we learn that de Lapersonne, E. Landolt, Badal, and Lagrange continue to edit the periodical, assisted, and not, as stated, replaced, by Drs. Truc, Rollet, Frenkel, and Duverger.

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Mary Louisa Prentice Montgomery Lectureship

APPLICATIONS are invited for the Mary Louisa Prentice Montgomery Lectureship in Ophthalmology of the College of Surgeons of Ireland. The Lecturer is appointed for one year, but is eligible for re-appointment year by year for a period not exceeding five years. The salary is approximately £150 per annum. Applications to reach the Registrar of the College on or before March 4, 1920.